

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau

## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>7</sup> : <b>E21B 33/10</b>	<b>A1</b>	(11) International Publication Number: <b>WO 00/66877</b>
		(43) International Publication Date: 9 November 2000 (09.11.00)

(21) International Application Number: PCT/US00/10443

(22) International Filing Date: 18 April 2000 (18.04.00)

(30) Priority Data:  
09/303,201 30 April 1999 (30.04.99) US(71) Applicant: THRU-TUBING TECHNOLOGY, INC. [US/US];  
402 Machine Loop, Scott, LA 70583 (US).(72) Inventor: GAZEWOOD, Michael, J.; 402 Machine Loop,  
Scott, LA 70583 (US).(74) Agent: DOMINGUE, C., Dean; Domingue & Waddell, PLC,  
Suite 515, Box 75, 600 Jefferson Street, Lafayette, LA  
70501 (US).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

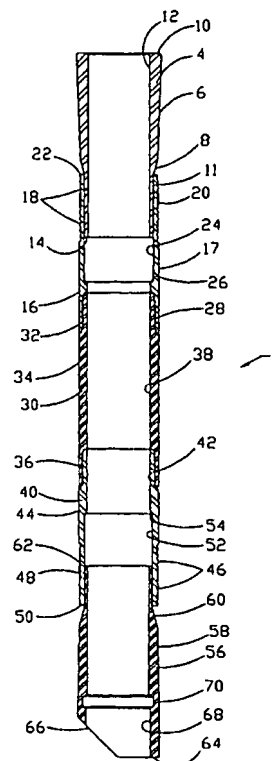
Published

With international search report.

(54) Title: RIBBED SEALING ELEMENT AND METHOD OF USE

## (57) Abstract

A device for sealing and anchoring within a tubular member. The device comprises a top (4) and bottom swage member (56) disposed within the tubular member, each swage member having a longitudinal center of axis. Also included is a first sealing member (16) disposed about the top swage member, and the first sealing member containing a first plurality of circumferential ribs (18) disposed thereabout. The device may also include a second sealing member (40) disposed about the bottom swage member, and the second sealing member containing a second plurality of circumferential ribs (46) disposed thereabout. The device further comprises a setting apparatus for driving the top swage longitudinally downward relative to its longitudinal axis and for driving the bottom swage longitudinally upward relative to its longitudinal axis. A method for anchoring and sealing a device within a tubular member is also included.



*FOR THE PURPOSES OF INFORMATION ONLY*

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon	KR	Republic of Korea	PL	Poland		
CN	China	KZ	Kazakhstan	PT	Portugal		
CU	Cuba	LC	Saint Lucia	RO	Romania		
CZ	Czech Republic	LI	Liechtenstein	RU	Russian Federation		
DE	Germany	LK	Sri Lanka	SD	Sudan		
DK	Denmark	LR	Liberia	SE	Sweden		
EE	Estonia			SG	Singapore		

1                   **RIBBED SEALING ELEMENT AND METHOD OF USE**

2

3

4                   **BACKGROUND OF THE INVENTION**

5

6                   This invention relates to a ribbed sealing element for use in a well bore. More

7 particularly, but not by way of limitation, this invention relates to a ribbed sealing element and

8 method for using the ribbed sealing element in a well bore.

9                   In the oil and gas industry, a well is drilled to a subterranean hydrocarbon reservoir. A

10 casing string is then run into the well and the casing string is cemented into place. The casing

11 string can then be perforated and the well completed to the reservoir. A production string

12 may be concentrically placed within the casing string and production of the hydrocarbons may

13 begin, as is well understood by those of ordinary skill in the art.

14                  During the drilling, completion, and production phase, operators find it necessary to

15 perform various remedial work, repair and maintenance to the well, casing string, and

16 production string. For instance, holes may be created in the tubular member accidentally or

17 intentionally. Alternatively, operators may find it beneficial to isolate certain zones.

18                  Regardless of the specific application, it is necessary to place certain down hole assemblies

19 such as a liner patch within the tubular member, and in turn, anchor and seal the down hole

20 assemblies within the tubular member.

21                  Numerous devices have been attempted to create a seal and anchor for these down

22 hole assemblies. For instance, in U.S. Patent No. 3,948,321 entitled "LINER AND

23 REINFORCING SWAGE FOR CONDUIT IN A WELLBORE AND METHOD AND

24 APPARATUS FOR SETTING SAME" to Owen et al, a method and apparatus for emplacing

1 a liner in a conduit with the use of swage means and a setting tool is disclosed. The Owen et  
2 al invention anchors and seals the liner within the wellbore.

3 Despite these advances, the prior art suffers from the ability to properly anchor the  
4 down hole assembly into the tubular member. Also, the prior art devices do not properly seal  
5 within the tubular members. Therefore, there is a need for a device that will properly set,  
6 anchor and seal within a tubular member.

7

8

9

#### SUMMARY OF THE INVENTION

10

11 A device for sealing and anchoring within a tubular member is disclosed. The device  
12 comprises a top swage member disposed within the tubular member, with the top swage  
13 member having a longitudinal center of axis. Also included is a first sealing member disposed  
14 about the top swage member, with the first sealing member containing a first plurality of  
15 circumferential ribs disposed about the first sealing member. The device also includes a  
16 second sealing member that is attached to the first sealing member, with the second sealing  
17 member containing a second plurality of circumferential ribs disposed about the second sealing  
18 member.

19 A bottom swage member is disposed within the second sealing member, with the  
20 bottom swage member having a longitudinal center of axis. The device further comprises a  
21 setting means for driving the top swage longitudinally downward relative to the top swage's  
22 longitudinal center axis and for driving the bottom swage longitudinally upward relative to the  
23 bottom swage's center axis.

24 The device may further comprise an extension member disposed between the first

1        sealing member and the second sealing member. The extension member will have a first end  
2        connected to the first sealing member and a second end connected to the second sealing  
3        member. In the preferred embodiment, the top swage member has a first cylindrical surface  
4        that extends to a second conical surface, and wherein the first cylindrical surface is disposed  
5        within the first sealing member. Additionally, the bottom swage member will have a first  
6        cylindrical surface that extends to a second conical surface, with the first cylindrical surface  
7        being disposed within the second sealing member.

8                In one of the embodiments, the ribs of the first and second sealing member is a series  
9        of grooves, with the grooves having a radius of curvature of between 0.030 inches to 0.060  
10       inches, and wherein the outer diameter of the series of grooves is essentially equal to the outer  
11       diameter of the first sealing member. Additionally, the first and second sealing member may  
12       have disposed thereon an elastomeric seal such as an o-ring.

13               In the preferred embodiment, the first and second sealing member is comprised of a  
14       metal having a hardness that is equal to or less than 105 on the Rockwell B scale, and wherein  
15       the metal is medium to high ductility and medium to low hardness; moreover, the preferred  
16       micro structure of the metal is to be spheroidized but some pearlitic micro structures are  
17       acceptable. Further, the top swage member and the bottom swage member, in the preferred  
18       embodiment, is comprised of a high tensile steel, that has a hardness generally higher than 108  
19       on the Rockwell B scale.

20               A method of sealing and anchoring a device within a tubular member is also disclosed.  
21       The method includes positioning the device in an internal diameter wall of the tubular member  
22       and driving the top swage longitudinally downward relative to the top swage's longitudinal  
23       center of axis with a setting tool member. The setting tool member is selectively attached to  
24       the device. The method further includes expanding the first sealing member radially outward

1 and embedding at least one of the first plurality of circumferential ribs into the inner diameter  
2 wall which in turn seals and anchors the device within the internal diameter wall. The  
3 embedding of the ribs produces a slight circumferential indentation profile in the internal  
4 diameter wall.

5 The method further comprises driving the bottom swage longitudinally upward relative  
6 to the bottom swage's longitudinal center of axis and expanding the second sealing member  
7 radially outward. This expansion will embed at least one of the second plurality of  
8 circumferential ribs into the inner diameter wall which in turn seals and anchors the device  
9 within the internal diameter wall. The embedding of the ribs produces a slight circumferential  
10 indentation profile in the internal diameter wall.

11 In one of the embodiments, the first sealing member further comprises a first  
12 elastomeric member circumferentially disposed thereon and wherein the step of expanding the  
13 first sealing member radially outward includes forcing the first elastomeric member against the  
14 internal diameter wall so that a secondary seal is provided for the device within the internal  
15 diameter wall. Additionally, the second sealing member may further comprise a second  
16 elastomeric member circumferentially disposed thereon and wherein the step of expanding the  
17 second sealing member radially outward includes forcing the elastomeric member against the  
18 internal diameter wall so that a tertiary seal is provided for the device within the internal  
19 diameter wall.

20 In one of the embodiments, the step of driving the top and bottom swage upward and  
21 downward includes pumping a fluid down the inner bore and forcing a power piston in the tool  
22 in an upward direction so that the lower swage is moved upward thereby forcing an outer  
23 sleeve in the tool in a downward direction so that the upper swage is moved downward. The  
24 continued pumping will result in the shearing of a shear ring selectively attaching the device to

1 the setting tool means. Next, the setting tool means may be retrieved from the tubular  
2 member.

3 An advantage of the present invention includes having a seal element creating a metal-  
4 to-metal seal within the tubular member. Another advantage is that a series of ribbed seal  
5 elements are created. Each of the individual circumferential ribs may create a seal so that  
6 multiple seals may be created with the ribbed elements. Yet another advantage is that the  
7 ribbed seal elements are harder to damage than elastomeric types currently used.

8 Still yet another advantage is that since the individual rows of sealing elements are  
9 actually embedded, the device functions as an anchor to the device that is set in a tubular  
10 member. The embedded annular rings affix the device within the tubular string so that the  
11 device remains stationary during subsequent operations.

12 Still yet another advantage is that a polymeric seal may also be included with the novel  
13 sealing element. Another advantage is that the inner diameter wall of the tubular member that  
14 the device is set within does not require the degree of cleanliness as is the case with polymeric  
15 seals. Yet another advantage is that the novel seal element may be employed with tubing  
16 patches, casing patches, gravel pack assemblies, and other down hole assemblies that are  
17 required to be hung-off within the tubular string.

18 A feature of the present invention includes the ribbed sealing elements having a radius  
19 of curvature which form individual rings. The individual rings are not spirally interconnected  
20 such as thread means. Another feature is that the sealing mechanism may have a series of  
21 ribbed sealing elements followed by a polymeric seal followed by another series of ribbed  
22 sealing elements. Yet another feature is that the design can be used in highly deviated and  
23 horizontal tubular members, as well as in subterranean well bores and surface pipe lines that  
24 may destroy an elastomeric seal during conveyance into the desired position in the well bore.

1 Prior art slips set into a tubular member tend to cause a stress concentration at the  
2 point of engagement with the tubular member. This point of stress concentration can cause  
3 problems including causing a weak point in the tubular member. Accordingly, another feature  
4 of the present invention is that the individual rows of sealing elements that are embedded into  
5 the tubular member produce a slight circumferential indentation profile in the production  
6 tubing wall that creates a substantially lower stress concentration in the production tubing as  
7 opposed to the sharp indentations of a prior art slip for anchoring strength. These and many  
8 other uses of the present novel invention will be apparent from a reading of the detailed  
9 description of the preferred embodiments.

#### 11 **BRIEF SUMMARY OF THE DRAWINGS**

13 FIGURE 1 is a cross-sectional view of the novel device before the engagement of the  
14 sealing mechanisms.

16 FIGURES 2A-2B are a cross-sectional view of the device of FIGURE 1 along with the  
17 setting tool means for setting the device within a tubular member.

19 FIGURE 2C is a cross-sectional view of the device taken along line I-I of FIGURE  
20 2A.

22 FIGURE 2D is a cross-sectional view of the device taken along line II-II of FIGURE  
23 2B.



1           FIGURES 3A-3B are a cross-sectional view of the device of FIGURES 2A-2B  
2     illustrating the device in the set position.

3  
4           FIGURES 4A-4B are a cross-sectional view of the device of FIGURES 2A-2B  
5     illustrating the setting tool being retrieved from the device.

6  
7           FIGURE 5 is a cross-sectional view of the device of FIGURE 1 in the set position.

8  
9           FIGURE 6A is a cross-sectional view of the device of FIGURE 5 illustrating the  
10    device in the set position in a tubular member.

11  
12          FIGURE 6B is a close-up view the ribbed sealing elements taken from FIGURE 6A.

13  
14          FIGURE 7 is a cross-sectional view of a second embodiment of the present invention.

15  
16          FIGURE 8A is a cross-sectional view of the ribbed sealing element of the present  
17    invention.

18  
19          FIGURE 8B is a close-up view of the ribs of FIGURE 8A.

20

21

22

23

24

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to Fig. 1, a cross-sectional view of the novel device 2 before engagement of the sealing mechanisms will now be described. The device 2 generally contains a top swage 4. The top swage 4 contains a first tapered outer cylindrical surface 6 that extends to a conically tapered surface 8 which in turn extends to the second outer cylindrical surface 10. The top swage 4 has a top end 10 that extends radially inward to the inner bore surface 12 that terminates at the end 14. In the preferred embodiment, the top swage 4 is made of high tensile steel, having a 108 or higher on the Rockwell B scale.

The top sealing member 16 consist of an outer cylindrical surface 17 having a series of ribbed sealing elements denoted by the numeral 18. The ribbed sealing elements 18 comprises an annular groove formed in the outer cylindrical surface 17, with the groove having (in one of the embodiments) a radius of curvature that will be described in greater detail later in the application. In the preferred embodiment, the circumferential ribbed sealing elements 18 will generally have an outer diameter that is equal to the outer diameter of the outer cylindrical surface 17.

The outer cylindrical surface also has contained thereon an elastomeric seal 20, also referred to as an o-ring or polymeric seal, that is also utilized in providing a seal with an inner wall of a concentric tubular member, as will be described later in the application. The sealing member 16 has a first end 22 that extends radially inward to an inner bore 24, shoulder 26, and internal thread means 28. The sealing member 16 is a metal material having a hardness of 105 or less on the Rockwell B scale, in the preferred embodiment.

The sealing member 16 is threadedly attached to the extension member 30. The extension member 30 has external thread means 32 that advances to the outer cylindrical

1 surface 34. Extending radially inward is the internal thread means 36 that in turn extends to  
2 the inner bore 38.

3 The internal thread means 36 is threadedly mated to the lower sealing member 40 via  
4 the external thread means 42. The lower sealing member 40 contains the outer cylindrical  
5 surface 44 that has a series of ribbed sealing elements denoted by the numeral 46. The ribbed  
6 sealing elements 46 comprises an annular groove formed in the outer cylindrical surface 44. In  
7 the preferred embodiment, the circumferential ribbed sealing elements 46 will generally have  
8 an outer diameter that is equal to the outer diameter of the outer cylindrical surface 44.

9 The outer cylindrical surface also has contained thereon an elastomeric seal 48 also  
10 referred to as an o-ring, that is also utilized in providing a seal with an inner wall of a  
11 concentric tubular member, as will be described later in the application. The sealing member  
12 40 has a first end 50 that extends radially inward to an inner bore 52, and shoulder 54. In the  
13 preferred embodiment, the sealing member 40 is also a metal member, with the metal having a  
14 hardness of 105 or lower on the Rockwell B scale. The device 2 will also contain a bottom  
15 swage 56. The bottom swage 56 contains a first tapered outer cylindrical surface 58 that  
16 extends to a conically tapered surface 60 which in turn extends to the second outer cylindrical  
17 surface 62. The bottom swage 56 has a bottom end 64 that contains a chamfered surface 66  
18 which in turn extends radially inward to the inner bore surface 68 that contains the annular  
19 groove 70. The bottom swage 56 is also made of metal and in the preferred embodiment is a  
20 high tensile steel that has a hardness of 108 or higher on the Rockwell B scale.

21 Referring now to Figs. 2A-2B, a cross-sectional view of the device 2 of Fig. 1 along  
22 with the setting tool means for setting the device within a tubular member will now be  
23 described. It should be noted that like numbers appearing in the various figures refer to like  
24 components. The setting tool means consist of a first sub 74 that is attached to a second

1 cylindrical member 76 that is in turn connected to the bushing 78. The bushing 78 extends to  
2 the third cylindrical member 80 that is threadedly attached to the fourth cylindrical member 82.  
3 The member 82 abuts the device 2 at the end 10.

4 The setting tool means also includes the power piston 84 that is threadedly attached to  
5 the adapter rod 86 which in turn extends to the first adapter rod extension 88, with first  
6 extension being connected to the second adapter rod extension 90 via the connector sub 92.  
7 The second rod extension 90 is made up to the shear ring bushing 94, with the bushing 94  
8 having a shear ring 96. The shear ring 96 is selected for separation at a preselected tensile pull  
9 force, as is recognized by those of ordinary skill in the art. The shear ring 96 is in turn made  
10 up to the collet 98, with the collet 98 extending to the latch member 100.

11 The latch member 100 engages the annular groove 70. Threadedly attached to the  
12 bottom end of the rod is the collet support nut 102, with the support nut containing the angled  
13 shoulder 104 that engages the collet 98 to seat the latch member 100 into the annular groove  
14 70. Other types of setting tool means are commercially available. For instance, one type is  
15 available from Owen Oil Tools, Inc. of Fort Worth, TX under the names Casing Patch and  
16 Tubing Patch. The Catalog Entry for the Casing Patch and Tubing Patch from Owen Oil  
17 Tools, Inc. was made a part of the Information Disclosure Statement and is herein  
18 incorporated by reference. Further, the U.S. Patent No. 3,948,321 to Owens et al (referenced  
19 earlier) also discloses the setting means and is incorporated herein by reference. It should be  
20 noted that other types of setting means are commercially available such as explosively actuated  
21 means from Owen Oil Tools, Inc.

22 Reference is now made to Fig. 2C which is a cross-sectional view of the device 2 taken  
23 along line I-I of Fig. 2A. Thus, the power piston 84 is shown disposed within the second  
24 cylindrical member 76. The power piston 84 will have the inner bore 106 that stretches to the

1 lateral passage 108. Fig. 2D depicts a cross-sectional view of the device 2 taken along line II-  
2 II of Fig. 2B. This figure illustrates the rod 90 along with the angled shoulder 104 of the  
3 collet support nut 102. The collet latch member 100 is also depicted.

4 In operation, the setting tool means will work to operatively move the top swage 4 and  
5 the bottom swage 56 relative to the top sealing member 16 and the bottom sealing member 56  
6 thereby expanding the top sealing member 16 and bottom sealing member 56 in accordance to  
7 the teachings of the present invention. In Figs. 3A-3B, the cross-sectional view of the device  
8 2 in the set position is illustrated.

9 Thus, an operator would pump, in the preferred embodiment, a fluid down the inner  
10 106 which is transmitted to the passage 108. The fluid would then enter the chamber 110  
11 causing the power piston 84 to move longitudinally upward relative to the center of the  
12 device's 2 axis. During this pumping cycle, and as the power piston 84 is being moved  
13 upward, the fluid also acts on the setting tool's cylindrical member 80 which in turn forces the  
14 surface 82 against the top swage 6, forcing the top swage 6 into the top sealing member 16.

15 As the conical surface 8 continues to expand the top swage 6, the ribbed sealing  
16 elements 18 will be forced into engagement with the tubular member. At the bottom swage  
17 56, the collet member 98 is being forced longitudinally upward relative to the center of axis of  
18 the device 2, with the latch members 100 engaging the annular groove 70 thereby forcing the  
19 bottom swage 56 longitudinally upward into the lower sealing member 40. As the conical  
20 surface 60 is forced into the lower sealing member 40, the lower sealing member 40 will  
21 expand outward so that the ribbed sealing elements 46 engage the inner walls of the concentric  
22 tubular member providing a metal-to-metal seal. As a secondary seal, the elastomeric seals 20  
23 and 48 will also engage the inner walls of the concentric tubular member.

24 An advantage of the present invention is that while there may be 15 rows of ribbed

1 elements (i.e. 15 rows of ribbed elements comprising the top sealing element 18), not all of the  
2 rows need provide a seal with the inner diameter wall. This is also the case with the lower seal  
3 elements. Further, the stress concentration of prior art slips can cause damage to the inner  
4 tubular walls which can lead to weak points and failure of the tubular which is now obviated  
5 by the present invention. In the present invention, the individual rows of sealing elements that  
6 are embedded into the tubular member produce a slight circumferential indentation profile in  
7 the inner tubular wall that creates a substantially lower stress concentration in the tubular as  
8 opposed to the sharp indentations of a prior art slip for anchoring strength.

9 FIGURES 4A-4B are a cross-sectional view of the device of FIGURES 2A-2B  
10 illustrating the setting tool being retrieved from the device. Once a predetermined amount of  
11 force has been applied via the pumping, the shear ring 96 will shear. This occurs when the  
12 upward force of the adapter rod 90 exceeds the shear strength of the shear ring 96. The first  
13 sub 74 is operatively connected to an apparatus such a wireline, electric line, work string,  
14 coiled tubing string etc. Therefore, the operator may exert an upward pull on the first sub 74  
15 via, for instance, the work string. The power piston 84 along with the entire setting tool  
16 means can then be extracted from the device 2. As depicted, the power piston 84, bushing 84,  
17 adapter rods 88,90, collet 98 and angled shoulder 104 are attached and will be retrieved. Note  
18 that the shear ring 96 has separated into 96a and 96b.

19 Once the setting tool means has been retrieved, only the device 2 will remain, with the  
20 device 2 being in the set position as shown in the cross-section view of Fig. 5. The conically  
21 tapered surface 8 of the top swage 4 has caused the top sealing member 16 to expand radially  
22 outward which in turn has caused the series of ribbed sealing elements 18 to expand outward  
23 into engagement with the inner diameter walls of the tubular member. The elastomeric seal 20  
24 has also been expanded radially outward into engagement with the inner diameter wall.

1 Similarly, the bottom swage 56 has been driven longitudinally upward relative to the device's  
2 center of axis so that the conically tapered surface 60 forces the lower sealing member 40, and  
3 in particular, the ribbed sealing elements 46 radially outward into engagement with the inner  
4 walls of the tubular member. The elastomeric seal 48 will have also been expanded radially  
5 outward into engagement with the inner wall. Thus, the device 2 is set and anchored as shown  
6 in Fig. 5.

7 Referring now to Fig. 6A, a cross-sectional view of the set device 2 within a tubular  
8 member 120 will now be described. The tubular member 120 will generally be a cylindrical  
9 member having an outer diameter surface 122 that extends radially inward to an inner diameter  
10 surface 124. In one embodiment, the tubular 120 may be a highly deviated well (angle of 45  
11 degrees or greater) or horizontal well. The portion of the top sealing member 16 abutting the  
12 conical surface 8 has been radially expanded outward causing at least some of the series of  
13 ribbed sealing elements 18 as well as the elastomeric element 20 to sealingly engaged inner  
14 diameter surface 124. Likewise, that portion of the lower sealing member 40 abutting the  
15 conical surface 8 has been radially expanded outward causing at least some of the series of  
16 ribbed sealing elements 46 as well as the elastomeric element 48 to sealingly engaged inner  
17 diameter surface 124.

18 Fig. 6A also depicts that the tubular member 120 contains a hole or perforation 126  
19 therethrough. Thus, it can be seen that the novel device herein disclosed will effectively  
20 isolate the perforation 126 from the inner portion of the tubular member by providing an upper  
21 seal and a lower seal. Notice that the device 2 contains a large inner bore therethrough so that  
22 other down hole tools and equipment may be lowered and/or raised therethrough. The  
23 embodiment of Fig. 6A depicts the mule shoe configuration 66 that allows for easy entry of,  
24 for instance, wireline tools that are required to be conveyed either into the tubular member

1 120 or out of the tubular member 120 as will be well understood by those of ordinary skill in  
2 the art.

3 An exploded view of the sealing faces of the device 2 is seen in Fig. 6B. Thus, the  
4 series of ribbed sealing elements are separated into two groups, 18a,b,c and 18d,e,f,g. As  
5 seen, the upper rows 18a, 18b, 18c are embedded into the inner wall surface 124 of the tubular  
6 member 120. As will be understood by those of ordinary skill in the art, this is because the  
7 cylindrical surface 6 and conical surface 8 has caused the greatest amount of radial expansion.  
8 The lower rows 18d, 18e, 18f, 18g do not have as many individual rows actually embedded  
9 into the inner wall surface 124 since the cylindrical surface 6 and conical member 8 has not  
10 caused as much radial expansion. In other words, individual row 18d may be slightly  
11 embedded whereas rows 18e, 18f, 18g have not been radially expanded enough to sealingly  
12 engage the inner wall 124.

13 An advantage of the present invention is that some individual rows (for instance rows  
14 18a,18b,18c, and 18d) may form a metal-to-metal seal while other individual rows (for  
15 instance rows 18e,18f,18g) do not form a seal. Thus, there are numerous back-up seals  
16 employed with each sealing mechanism. Also, the elastomeric seal means 20 is engaging the  
17 inner surface 124 thereby creating yet another tertiary seal. Still yet another advantage is that  
18 since the individual rows 18a-18d are actually embedded, the device functions as an anchor to  
19 the device that is set in a tubular member 120. The embedded annular rings affix the device  
20 within the tubular string. Further, an individual row does not necessarily have to create a seal  
21 face with the inner wall in order to aid in the anchoring. Thus, the elements serve a dual  
22 purpose so as to seal and anchor the device 2 within the tubular member.

23 According to the teachings of the present invention, the novel device 2 has many other  
24 applications. For instance, the novel device 2 may be used in order to set within a well bore a



1 down hole gravel pack assembly wherein the gravel pack assembly is attached to the bottom of  
2 the device 2. The device may also be employed to act as a bridge plug within the well bore.  
3 Such an example may be seen in Fig. 7 which is a cross-sectional view of the second  
4 embodiment of the present invention. In this case, only the top swage 4 and the top sealing  
5 member 16 are employed.

6 The embodiment of Fig. 7 includes the setting tool means that was previously  
7 described, which includes the power piston 84, adapter rods 88,90, bushing 94 and collet 98.  
8 The mode of operation remains generally the same in that the hydraulic fluid is pumped down  
9 into the inner bore 106 and wherein the hydraulic force will be transferred to the chamber  
10 which in turn will force the housing 80 downward and the collet 98 upward, forcing the swage  
11 4 downward in order to radially expand the sealing member 16 as previously described.

12 This embodiment includes a plank plug 128 that contains the external thread means  
13 130 that will threadedly attach to the internal thread means 132 of the sleeve extension  
14 member 30. The setting tool means will shear at the predetermined force via the shear ring 96,  
15 and thereafter, the setting tool means can be pulled from the tubular member as previously  
16 described. Once the device 2 is set, the embodiment of Fig. 7 will act as a plug since the  
17 sealing elements 18 and the o-ring means 20 will sealingly engage the inner tubular member  
18 and the inner bore contains the plank plug 128.

19 Referring now to Fig. 8A, a cross sectional view of the ribbed sealing elements will  
20 now be described. In the embodiment shown in Fig. 8A, the individual rows are  
21 approximately 0.143 inches apart. This distance may vary considerably depending on the  
22 application. The distance is measured from the peak of one row to the peak of the subsequent  
23 row. The number of rows will vary depending on the application, size of the tubular member,  
24 depth of the well, anticipated pressures, etc. In the preferred embodiment, at least four rows

1 are included on an individual sealing member. It is possible to use triangularly shaped ribs to  
2 form a plurality of circumferential ribs and/or a combination of triangularly shaped ribs with a  
3 more rounded shaped rib as seen in Figs. 1 through 8.

4 Two individual rib rows (i.e. 18d & 18e) form a grooved portion. In the preferred  
5 embodiment, the radius of curvature of the groove is 0.0470 inches as shown in the exploded  
6 view of Fig. 8b. The Fig. 8b depicts the actual distance from the peak of 18d to the peak of  
7 18e as being 0.14286 inches. Fig. 8b also illustrates that in the preferred embodiment, the  
8 distance from the peak to the groove bottom is approximately 0.033 inches. The elastomeric  
9 seal means 20 is also included. It should be noted that the actual dimensions provided for the  
10 distance of one peak to another peak, as well as the radius of curvature, are exemplary. The  
11 actual physical dimensions that are employed will vary on the specific application.

12 The metal that the first and second sealing member is made of can vary. The metal  
13 must be malleable so that it can be deformed properly i.e. radially expanded by the swage. On  
14 the other hand, the metal must be hard enough to be able to embed within the inner walls of  
15 the tubular member in order to form a proper seal and to anchor. The ribbed sealing elements  
16 will also be coated with a Teflon type of coating which is commercially available from Great  
17 Lakes Chemical Group, Inc. under the registered trademark Everlube. Teflon is a trademark  
18 of DuPont Corporation.

19 Additionally, the swage members will usually have to be a harder metal as compared to  
20 the sealing members. A metal, as previously described, is used for the swages. The metal is  
21 then coated with a low-temperature, multi-state metal finishing process, based from chrome-  
22 plating technology with a process that is commercially available from Armoloy Company  
23 under the registered trademark Armoloy.

24 Changes and modifications in the specifically described embodiments can be carried

- 1 out without departing from the scope of the invention which is intended to be limited only by
- 2 the scope of the appended claims.

1

2

3 I claim:

4 1. A sealing and anchoring apparatus for use in a tubular member, the apparatus  
5 comprising:

6 -a top swage member disposed within said tubular member, said top swage  
7 member having a longitudinal center of axis;

8 -a first sealing member disposed about said top swage member, said first  
9 sealing member containing a first plurality of circumferential ribs disposed about said first  
10 sealing member, and wherein said first sealing member has a top end and a bottom end;

11 -a second sealing member attached to said first sealing member, said second  
12 sealing member containing a second plurality of circumferential ribs disposed about said  
13 second sealing member, and wherein said second sealing member has a top end and a bottom  
14 end;

15 -a bottom swage member disposed within said second sealing member, said  
16 bottom swage member having a longitudinal center of axis;

17 -a setting means for driving said top swage longitudinally downward relative to  
18 said top swage's longitudinal center axis and for driving said bottom swage longitudinally  
19 upward relative to said bottom swage member's center of axis.

20

21 2. The apparatus of claim 1 further comprising:

22 - an extension member disposed between said first sealing member and said  
23 second sealing member, said extension member having a first end connected to the bottom end  
24 of said first sealing member and a second end connected to the top end of said second sealing

1 member.

2

3 3. The apparatus of claim 2 wherein said top swage member has a first cylindrical  
4 surface that extends to a second conical surface, and wherein said first cylindrical surface is  
5 concentrically disposed within said first sealing member.

6

7 4. The apparatus of claim 3 wherein said bottom swage member has a first cylindrical  
8 surface that extends to a second conical surface, and wherein said first cylindrical surface is  
9 concentrically disposed within said second sealing member.

10

11 5. The apparatus of claim 4 wherein said ribs of said first sealing member is a series of  
12 grooves, said grooves having a radius of curvature of approximately 0.0470 inches, and  
13 wherein said grooves have a height of approximately 0.033 inches.

14

15 6. The apparatus of claim 5 wherein said ribs of said second sealing member is a series  
16 of grooves, said grooves having a radius of curvature of approximately 0.0470 inches, and  
17 wherein said grooves have a height of approximately 0.033 inches.

18

19 7. The apparatus of claim 6 wherein said first sealing member further comprises an  
20 elastomeric seal.

21

22 8. The apparatus of claim 6 wherein said second sealing member further comprises an  
23 elastomeric seal.

24

1           9. The apparatus of claim 6 wherein said first sealing member and said second sealing  
2 member is comprised of a metal having a hardness of 105 or less on the Rockwell B scale.

3

4           10. The apparatus of claim 6 wherein said top swage member and said bottom swage  
5 member is comprised of a metal having a hardness of 108 or higher on the Rockwell B scale.

6

7           11. A method of sealing and anchoring a device within a tubular member comprising:

8                   -positioning the device in an internal diameter wall of the tubular member, the  
9 device comprising: a top swage member disposed within the tubular member, said top swage  
10 member having a longitudinal center of axis; a first sealing member disposed partially about  
11 said top swage member, said first sealing member containing a first plurality of circumferential  
12 ribs disposed about said first sealing member, and wherein said first sealing member has a top  
13 end and a bottom end;

14                   -driving said top swage longitudinally downward relative to said top swage's  
15 longitudinal center of axis with a setting tool member, said setting tool member being  
16 selectively attached to the device;

17                   -expanding the first sealing member radially outward;

18                   -embedding at least one of said first plurality of circumferential ribs into the  
19 inner diameter wall;

20                   -sealing the device within the internal diameter wall with at least one of said  
21 first plurality of circumferential ribs;

22                   -anchoring the device within the internal diameter wall with at least one of said  
23 first plurality of circumferential ribs.

24

1           12. The method of claim 11 wherein said device further comprises: a second sealing  
2           member attached to said first sealing member, said second sealing member containing a second  
3           plurality of circumferential ribs disposed about said second sealing member, and wherein said  
4           second sealing member has a top end and a bottom end; a bottom swage member disposed  
5           partially within said second sealing member, said bottom swage member having a longitudinal  
6           center of axis; and wherein the method further comprises:

7                        -driving said bottom swage longitudinally upward relative to said bottom  
8           swage's longitudinal center of axis;

9                        -expanding the second sealing member radially outward;

10                      -embedding at least one of said second plurality of circumferential ribs into the  
11           inner diameter wall;

12                      -sealing the device within the internal diameter wall with at least one of said  
13           second plurality of circumferential ribs;

14                      -anchoring the device within the internal diameter wall with at least one of said  
15           second plurality of circumferential ribs.

16

17           13. The method of claim 12 wherein the first sealing member further comprises a first  
18           elastomeric member circumferentially disposed thereon and wherein the step of expanding the  
19           first sealing member radially outward includes:

20                      -forcing the first elastomeric member against the internal diameter wall;

21                      -providing a secondary seal for the device within the internal diameter wall.

22

23           14. The method of claim 13 wherein the second sealing member further comprises a  
24           second elastomeric member circumferentially disposed thereon and wherein the step of

1 expanding the second sealing member radially outward includes:

- 2 -forcing the elastomeric member against the internal diameter wall;
- 3 -providing a tertiary seal for the device within the internal diameter wall;
- 4 -and wherein the step of driving said top and bottom swage upward and

5 downward includes:

- 6 -pumping a hydraulic fluid;
- 7 -forcing a power piston in the tool in an upward direction so that said lower
- 8 swage is moved upward;
- 9 -forcing an outer sleeve in the tool in a downward direction so that the upper
- 10 swage is moved downward.

11

12 15. The method of claim 14 further comprising:

- 13 -shearing a shear ring operatively attaching the device to the setting tool means;
- 14 -retrieving the setting tool means from the tubular member.

15

16 16. An apparatus for sealing and anchoring within a tubular member, the apparatus  
17 comprising:

- 18 -a top swage member disposed within said tubular member, said top swage
- 19 member having a longitudinal center of axis and having a first end and a second end;
- 20 -a first sleeve being at least partially disposed within the first end of said top
- 21 swage, said first sleeve containing a first plurality of circumferential ribs disposed thereon, and
- 22 wherein said first sleeve has a top end and a bottom end.

23

24 17. The apparatus of claim 16 further comprising:



1                   -a second sleeve attached to said first sleeve, said second sealing member  
2           containing a second plurality of circumferential ribs disposed thereon, and wherein said second  
3           sleeve has a top end and a bottom end;

4                   -a bottom swage member disposed within said second sealing member, said  
5           bottom swage member having a longitudinal center of axis and having a first end and a second  
6           end, and wherein said first end is disposed within said bottom swage member.

7

8           18. The apparatus of claim 17 further comprising:

9                   -a setting means for driving said top swage longitudinally downward relative to  
10          said top swage's longitudinal center axis and for driving said bottom swage longitudinally  
11          upward relative to said bottom swage's center axis.

12

13           19. The apparatus of claim 18 wherein said ribs of said first sealing member is a series  
14          of grooves, said grooves having a radius of curvature of between 0.030 inches to 0.060 inches,  
15          and wherein said ribs of said second sealing member is a series of grooves, said grooves  
16          having a radius of curvature of between 0.030 inches to 0.060 inches.

17

18           20. The apparatus of claim 19 wherein said first sleeve has disposed thereon a first  
19          elastomeric seal and wherein said second sleeve has disposed thereon a second elastomeric  
20          seal.

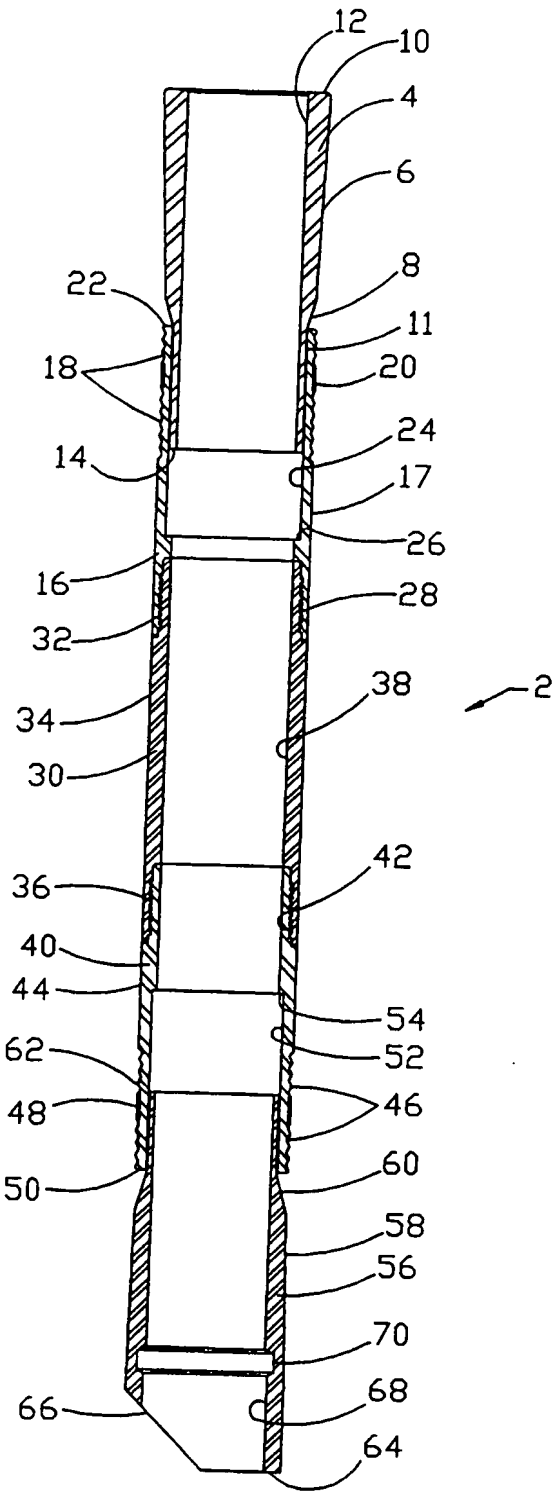
21

22

23          --->>>

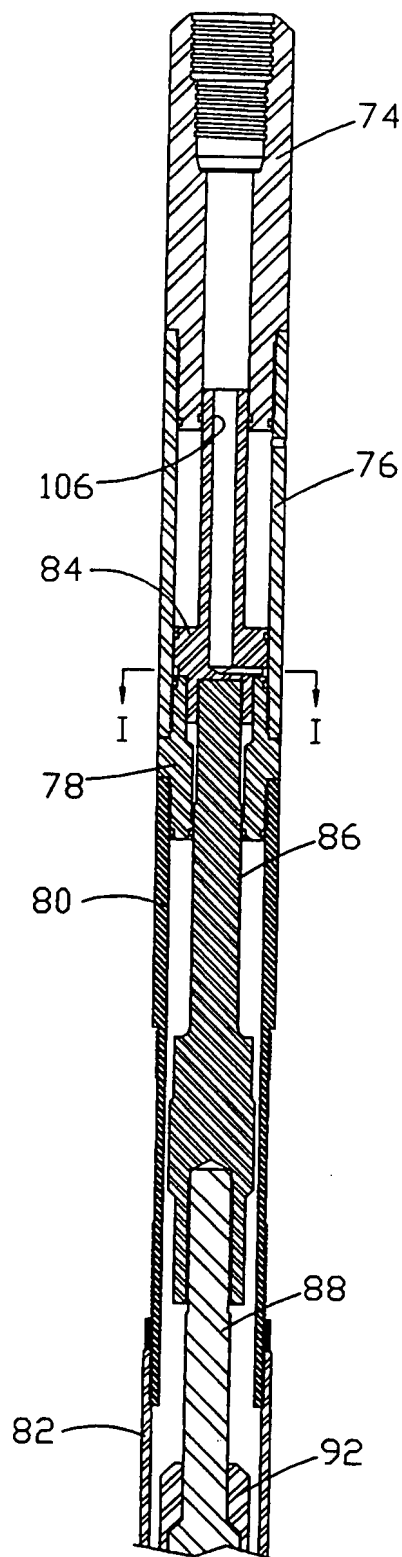
24

1/16



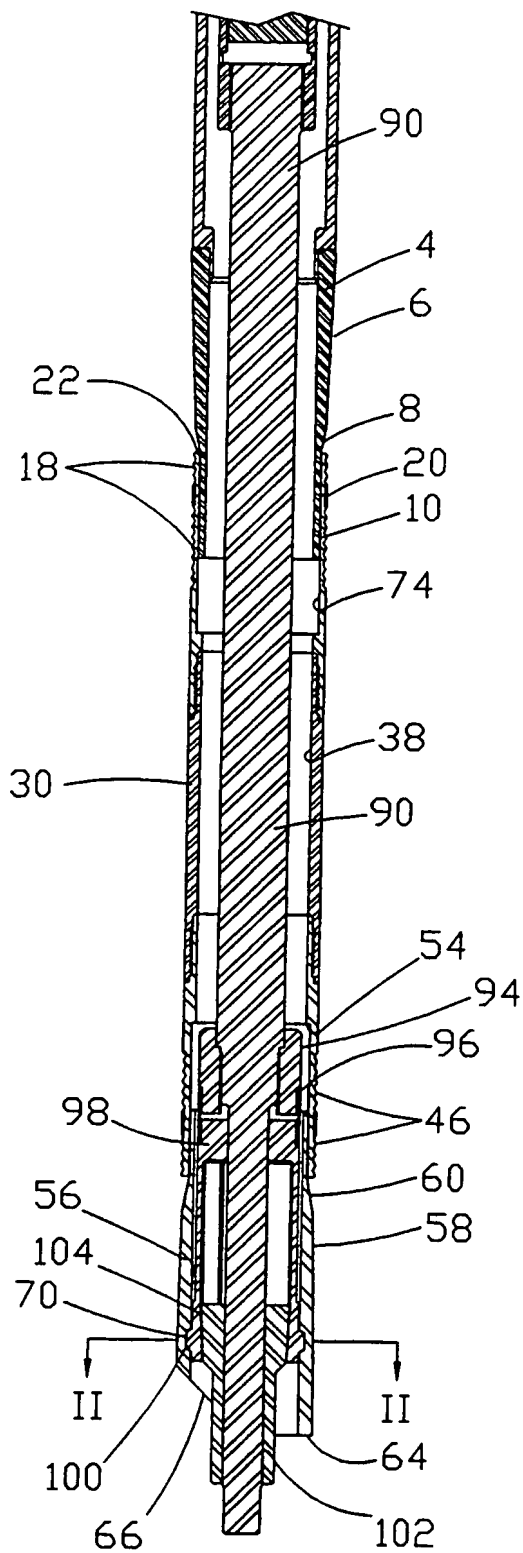
**FIGURE 1**

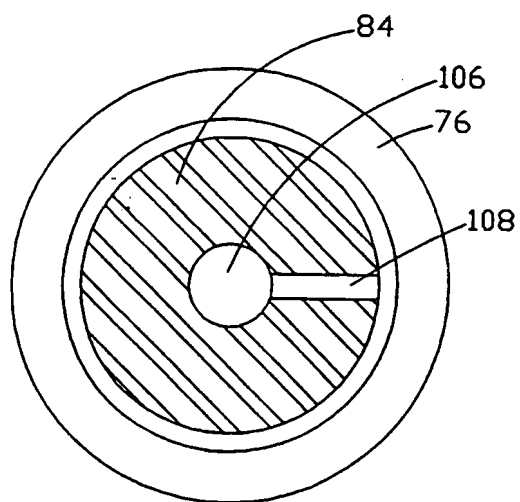
2/16



**FIGURE 2A**

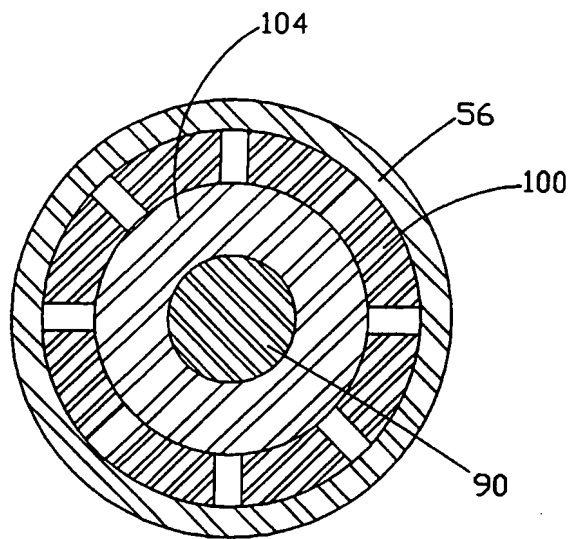
3/16

**FIGURE 2B**



**FIGURE 2C**

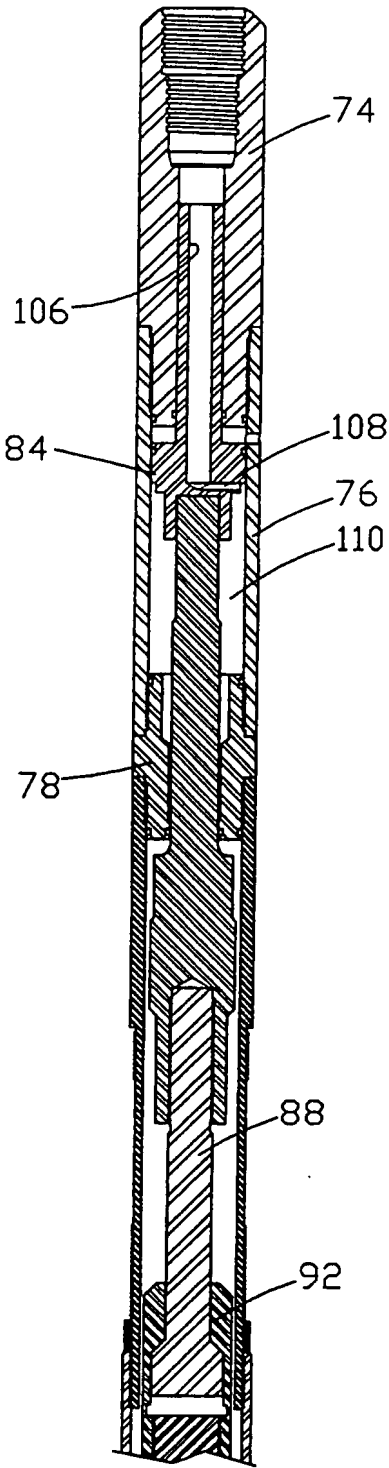
5/16



**FIGURE 2D**

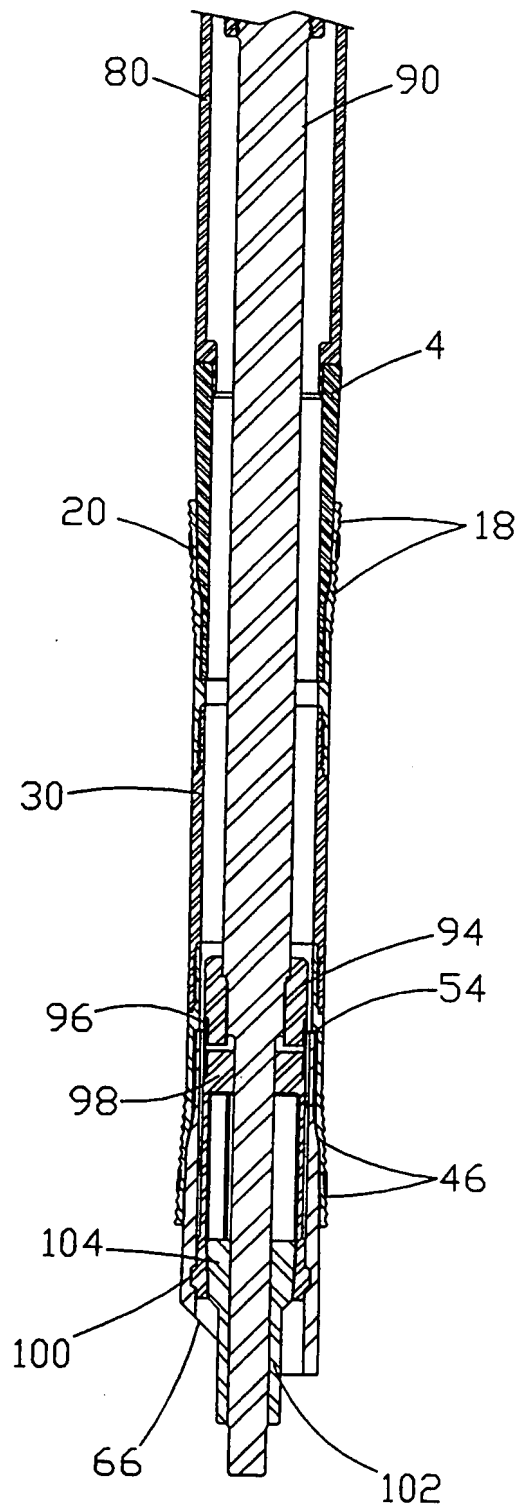
SUBSTITUTE SHEET (RULE 26)

6/16



**FIGURE 3A**

7/16

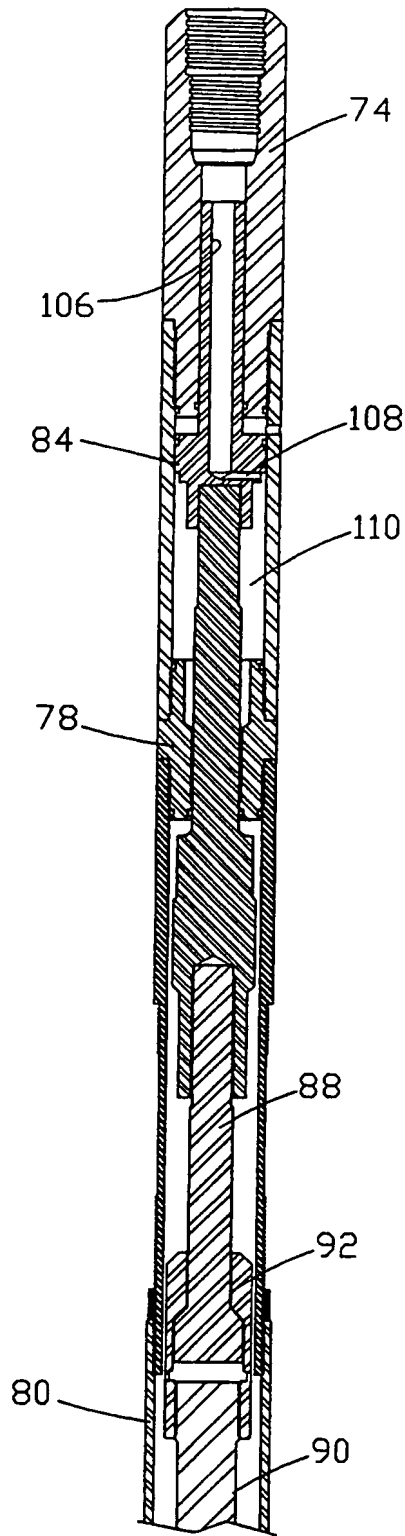


**FIGURE 3B**

SUBSTITUTE SHEET (RULE 26)

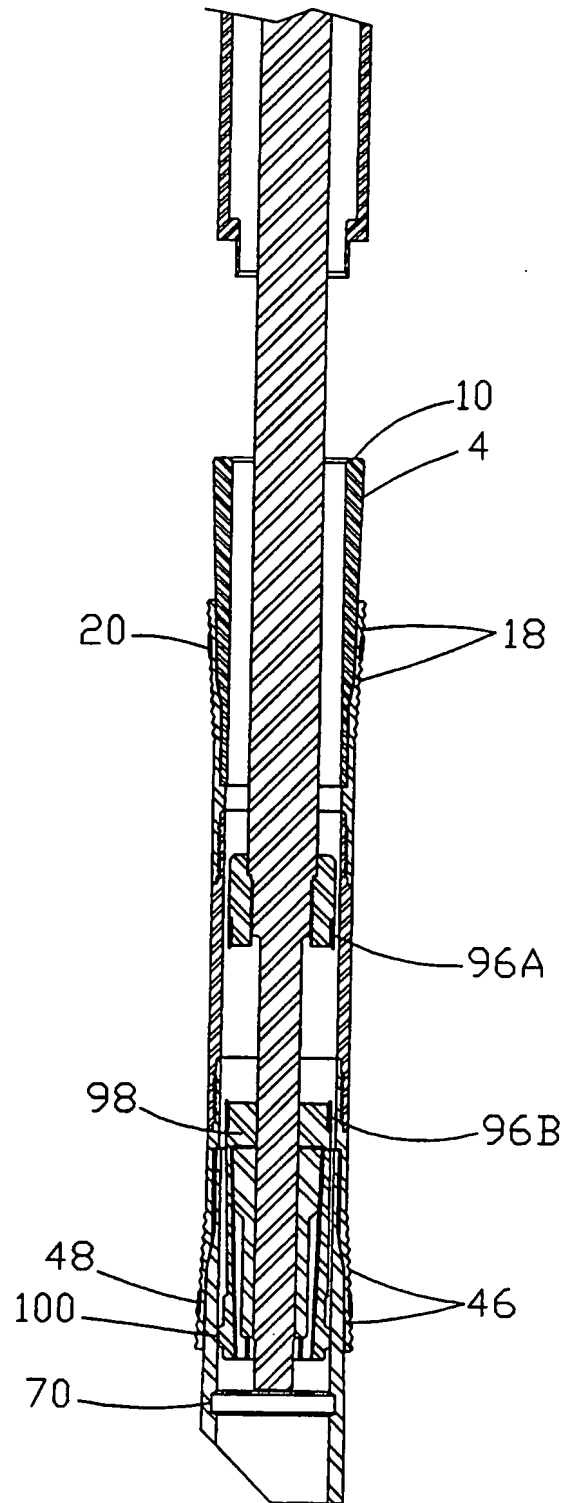


8/16



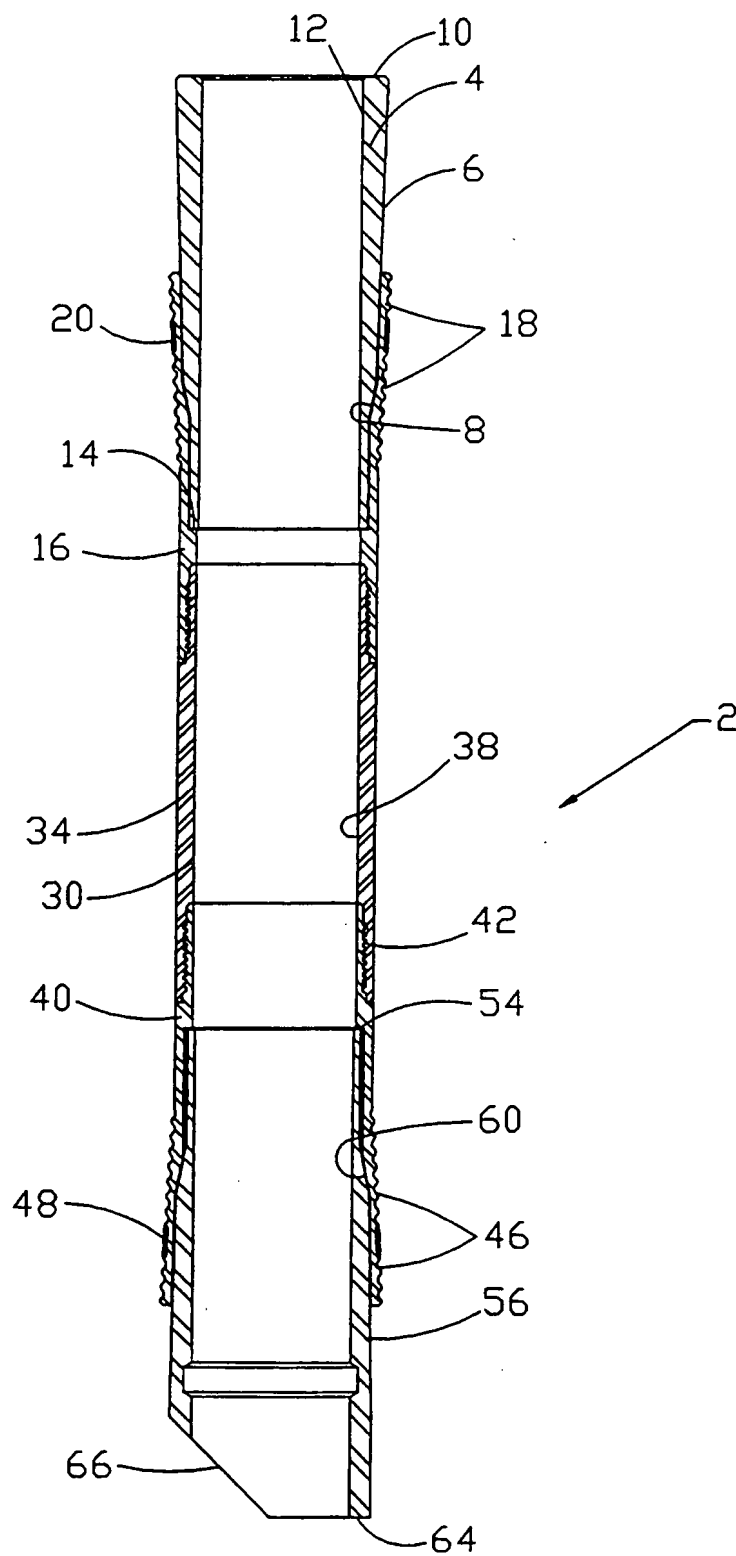
**FIGURE 4A**

9/16



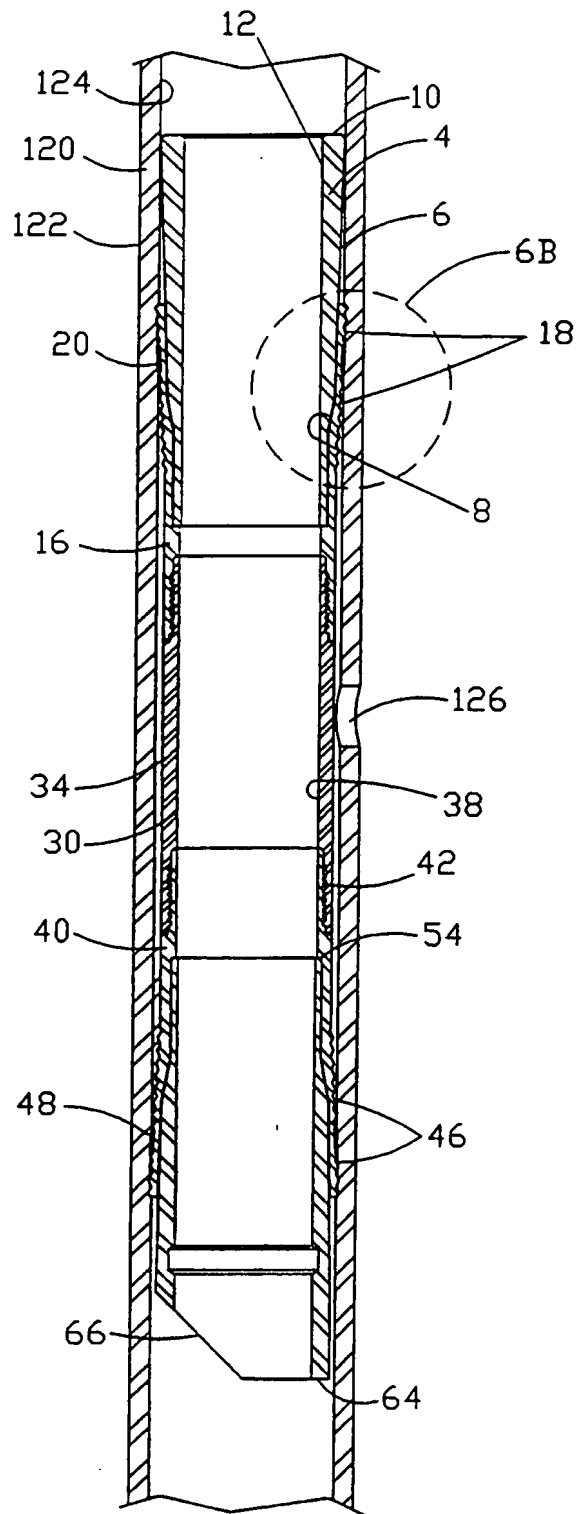
**FIGURE 4B**

10/16



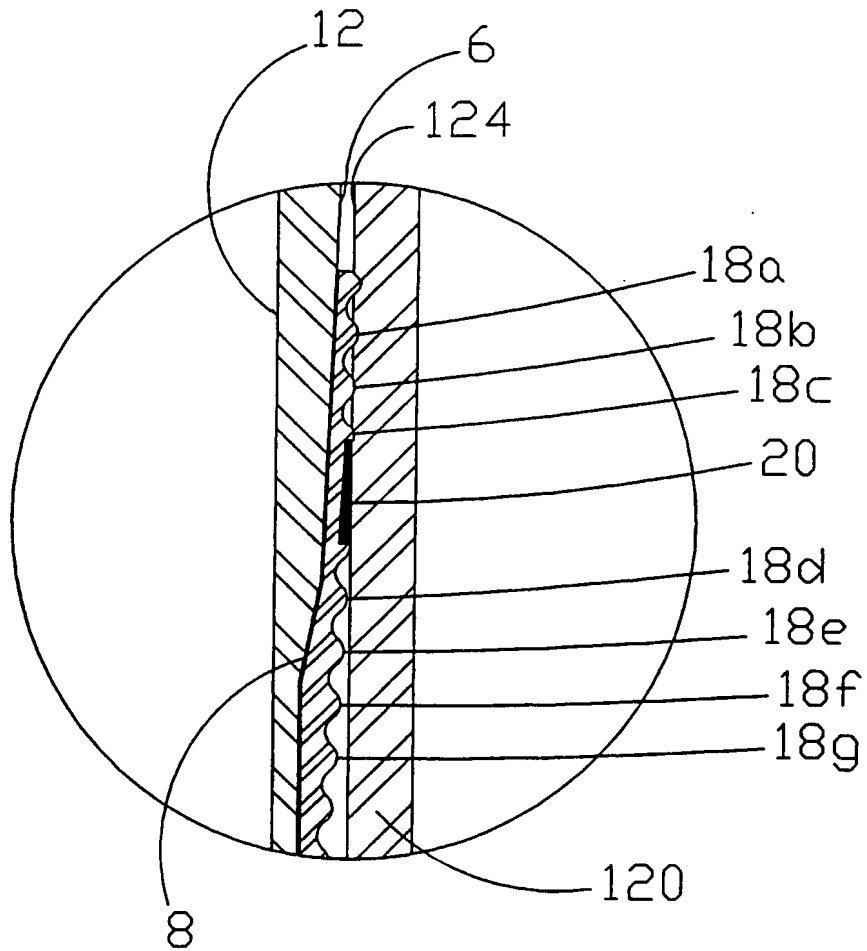
**FIGURE 5**

11/16



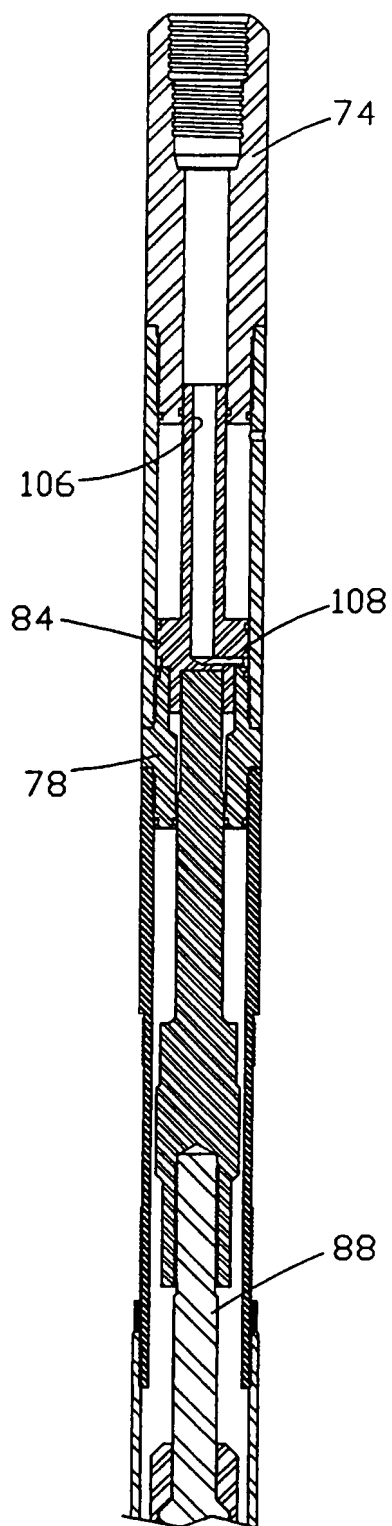
**FIGURE 6A**

12/16



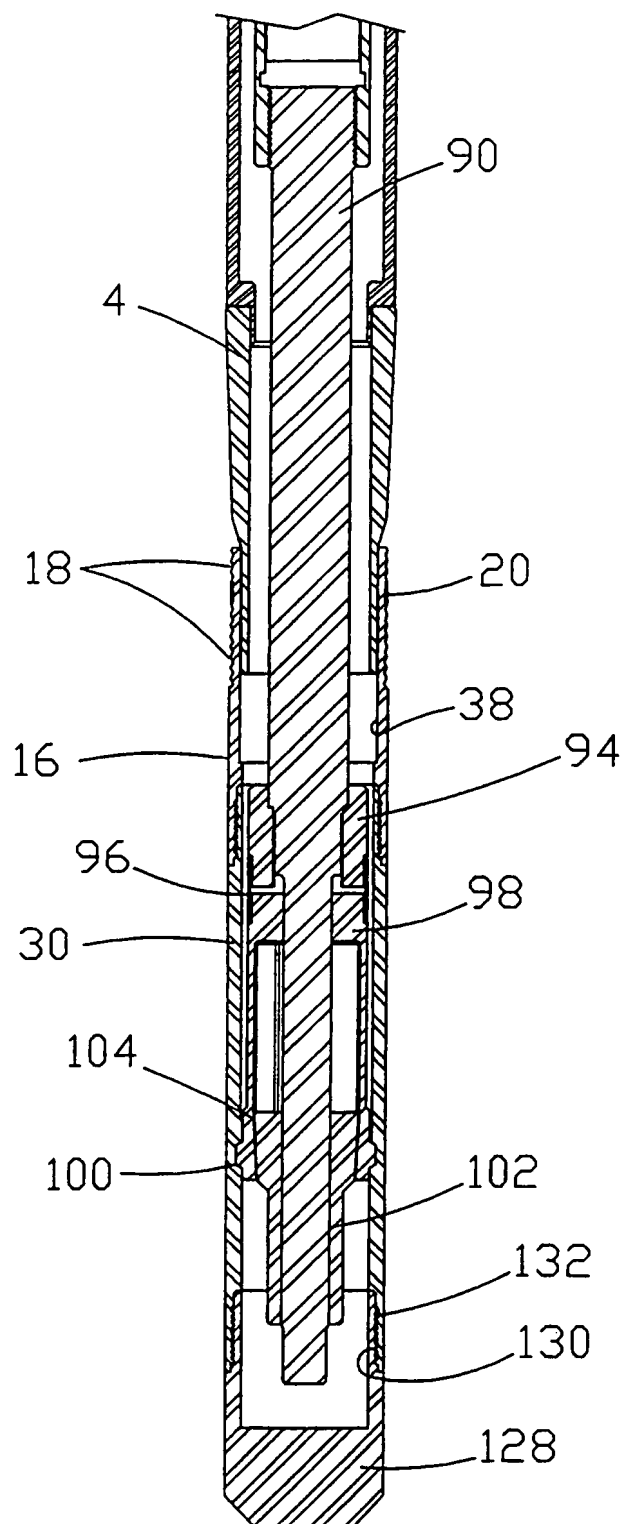
**FIGURE 6B**

13/16



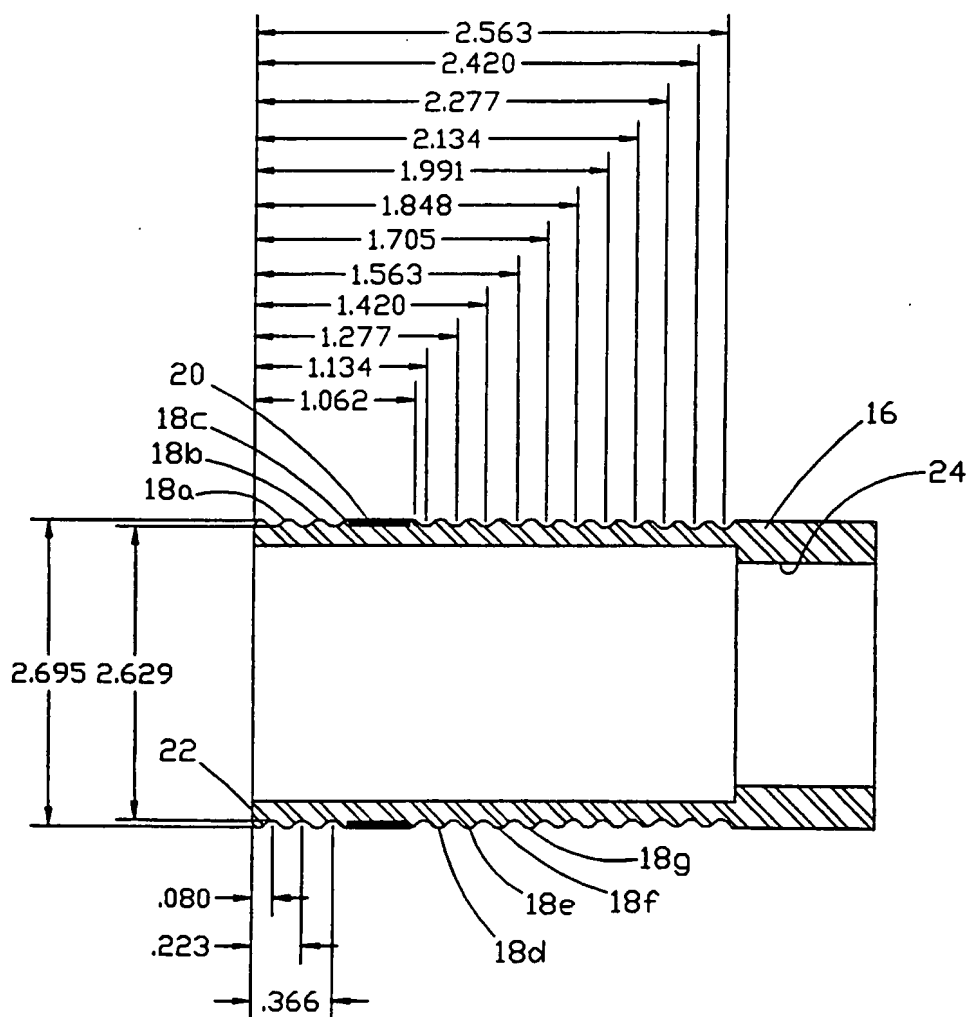
**FIGURE 7A**

14/16



**FIGURE 7B**

15/16

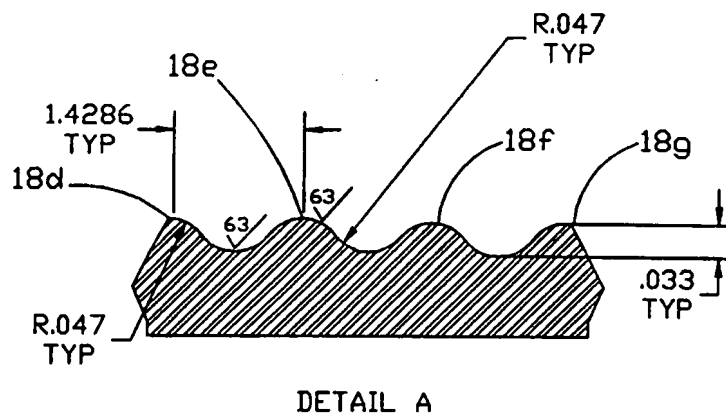


**FIGURE 8A**

SUBSTITUTE SHEET (RULE 26)



16/16

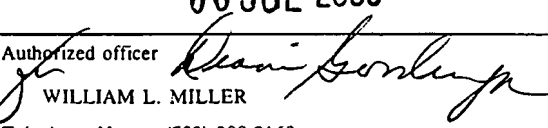


**FIGURE 8B**

SUBSTITUTE SHEET (RULE 26)

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US00/10443

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC(7) :E21B 33/10 US CL :277/336 According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) U.S. : 277/336, 322, 337, 338, 339, 340, 341, 342; 166/179, 118, 123, 207, 217  Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2,345,873 A (HART) 04 April 1944, entire document.	1,2,11,12,16-19
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* "A" "B" "L" "O" "P"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance earlier document published on or after the international filing date document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) document referring to an oral disclosure, use, exhibition or other means document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
Date of the actual completion of the international search 14 JUNE 2000		Date of mailing of the international search report 06 JUL 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230		Authorized officer  WILLIAM L. MILLER Telephone No. (703) 308-2168